Self Righting for Fast Electric Boats

Introduction

This may sound like stating the obvious - but a capsized boat can't win a race! This article looks at common causes of capsize and some practical ways to quickly get your boat back in the race.

Causes & excuses

In almost all cases the blame for a capsize can be laid squarely in the hands of the driver, namely:

- Collision with another boat (*He turned across in front of me*)
- Collision with a marker buoy (*I was concentrating on making a smooth turn*)
- Collision with debris (*That was unlucky. I must have hit a fish just under the surface*)
- Driving too hard for the prevailing conditions (*Oh dear! Something must have broken*)

Don't capsize

The nature of competitive racing means that capsizes are almost inevitable. But the best way to avoid unnecessary occurrences is to race within the capabilities of the boat. (*and the driver*)

With the advent of powerful brushless motors and light weight Lithium Polymer (Lipo) batteries more capsizes are being caused by racing too hard for the design of the hull and the prevailing conditions. That is, accelerating too hard, turning too quickly, or going too fast for the designed capabilities of the hull. In general, but particularly in rough and windy weather, it is essential to balance the throttle with the stability of the boat. (*That is - back off before it's too late*)

Self righting solutions

The techniques for self righting in common use can be divided into two main groups:

- Shaped superstructures
- Flood Chambers

There are other systems using the torque of the motor to right the boat and some other unique ideas for Hydroplanes but this article sticks to the most common for mono hulls.

Shaped superstructure

In this method the volume and shape of the superstructure is such that when the boat is upside down it is unstable. The superstructure being much more buoyant than the lower, heavier, part of the hull. This instability provides the impetus for the heavier part to sink and the lighter, buoyant top, to float thus correcting the boats orientation. Many early race boats were designed to quickly self right in this way but more modern hull designs favour a flood chamber. However this older method provides a very quick and effective self righting action. It is easy and straight forward to apply to a boat that is not designed to self right and so it remains a good practical solution. On the down side it adds some weight and aerodynamic drag.

A semi scale F600 with a faux engine cover and half round section which provides self righting

A commercial mono hull with a slightly different arrangement

How to retrofit self righting with a shaped superstructure

At its simplest an empty plastic drinks container firmly taped to the superstructure can provide an effective self righting mechanism. However it looks terrible and must contribute massively to aerodynamic drag. A much better option is to add shaped swimming flotation aid (noodle) to the superstructure and shape the front and trailing ends to provide some streamlining. Start with a large roughly shaped piece and stick it on the boat, which should be fitted with batteries, taped up and ready to go. Turn the boat over in the water and once a successful self righting action has been established the size and shape of the piece can be cut to make it a better fit, reduce its size, and streamline it. Test occasionally during the shaping to ensure a good positive action on self righting is still retained. Good quality waterproof double sided tape provides a neat and effective adhesive.

An MTMBC 'Have A Go' Wacky Racer modified to make it self righting

Flood Chamber

By far the best and most popular way to achieve self righting is to install a flood chamber in the hull. A section of the hull along the port side (*That's left for us landlubbers*) is segregated from the rest of the boat by a flood chamber wall. This section is open to the water and fills up when the boat is stationary or upside down. Forward motion of the boat empties the chamber through a hole in the transom. When the boat capsizes the chamber fills with water again and that side of the boat sinks. This motion turns the boat the correct way up and once again the forward motion of the boat can empty the chamber.
This method can add a little weight but does not create additional aerodynamic drag. Many modern race boat hulls are produced with integral flood chambers fitted, but for hulls which aren't, a flood chamber can be retrofitted with a little care & patience.

How to fit a flood chamber

This is a little more complicated and requires reasonable modelling skills and patience to complete but it is not beyond the ability of the average modeller. (*This includes F/E racers*) The method for retrofitting is similar to that for a new hull.

The position of the chamber wall is important, but it is not easy to calculate, so a degree of research is necessary to determine where to place it. Try and find guidance from someone else who has successfully installed a chamber in the same hull, or find some pictures on line, but if that is not possible you can use the following pointers to guide you.

a) The chamber wall is an unbroken wall running almost the length of the port side of the hull. It does not need to reach the front of the bow. It is glued and sealed along the bottom of the hull inside, the underside of the deck, and the transom.

b) Bearing in mind that the weight of water in the flood chamber needs to be enough to turn the boat over it is a good plan to keep it as large a volume as practical. There are a number of factors that will determine how far to the port side the wall is fitted including the positions of the motor, prop shaft, batteries and hatch cover. The picture below illustrates the following points.

c) For practical reasons it can't be any closer to the centre line than the edge of the hatch opening.

d) Sufficient room is needed for the batteries to be fitted to the port side of the prop shaft. This is the normal position for batteries in a racing boat as it helps to reduce torque effects and aids the self righting action.

Once the position has been determined mark it round the inside of the hull. Using card and scissors to cut a former that will fit closely making contact with the hull all round the edges.
Once you are satisfied with the fit use the former to cut the chamber wall out of thin fibreglass sheet or marine ply and sand it to make sure it fits snugly. This is a fiddly job but worth taking time over.

Keeping the wall as near towards the centre line as practical but leaving enough room for the batteries. Note the ESC mounted on the wall of the chamber to keep its weight to port.

At this stage it is a good idea to cut out the vents in the hull. These are necessary to let the air out, and the water into the flood chamber quickly on submerging, and the air in and the water out, when resuming the race. At this stage the cut outs will allow some access to the chamber which will help with positioning and gluing the wall. First I describe a method of fixing and sealing the wall and will explain the positioning of the vent cut outs later.

Position the wall and tack it at a number of places round the edges to hold it firmly in place with spots of super glue. Epoxy all the way round the edges of the wall leaving a small fillet of glue where the surfaces meet. I use Araldite Precision mixed with a small amount of Kevlar fibre to prevent it running away. Let it set, and then accessing the other side of the wall via the vents, run a bead of liquid epoxy resin glue all around the joint from the wet side of the wall. When the glue has set **do a leek test.**

The positioning and size of the vents is important to achieve effective and fast self righting. When the boat capsizes holes in the top of the chamber allow water in. For this to happen quickly the air must be allowed to escape whatever the attitude of the boat. Holes near the bow and in the transom allow this and the chamber can flood quickly. When the boat rights itself and starts forward motion the hole in the transom allows the water in the chamber to flow out. For this to happen quickly air must be allowed back into the chamber through the other vents. It is particularly important that the route out of the chamber through the transom is smooth and free from obstructions because exiting water can rebound off an obstruction back into the chamber. If the hull is stepped it will be necessary to cut a vent in the step to prevent water being held in the chamber.

A stepped mono hull showing vents on the top, near the bow and behind the step

The cut outs in the transom allowing a quick and easy exit for the water

Set up & test

With the boat fitted with batteries, taped up, and ready to go, turn it over in the water and check that the self righting works effectively. If it doesn't extra weight may be needed on the port side. Initially check to see if you can move any of the heavier components in the boat to the port side. Move them and then try again. If still not successful add weight to the extreme edge of the port side. It is then a question of trial and error to get the weight correct. Wheel balancing weights for alloy wheels are good for this and can easily be sourced from a local garage. Velcro stuck to boat and the weights allows easy adjustments until the correct weight is established. Later the weights can be fixed permanently inside the flood chamber.
A good positive self righting motion is needed as wind can interfere with action. Tests should be undertaken with Race number attached as the race number will also effect the action.

Conclusion

With a little thought and modelling skill these two methods can be used to make most mono hulled boats self right, and most importantly, get you back in the race.
Even with a self righting boat it is easy to loose a lap to competitors as the boat (*and driver*) recover from the capsize event. So my advice is to back off the throttle if the boat is showing signs of instability to allow it to settle before attempting to push the throttle further forward again. In this way you can achieve the best speed without capsizing. It is a balancing act with the boat "on the edge" much of the time but that's what makes it fun. All racers want to go faster and win so if you don't misjudge it and capsize occasionally you ain't trying hard enough.

Extra Tip

In the event of damage from a collision, or the boat not been taped up properly, it is possible the boat will fill with water and sink. (*just ask Tony*) Fill any spare space in the boat with light weight buoyant material to keep your boat afloat. e.g. Air bags, noodle, indoor practice golf balls, ping pong balls, polystyrene etc.

See you lake side

Dave

This sequence of pictures shows a large stepped mono hull self righting from initial crash & capsize to full recovery.
It was competing in a Mono 2 race at Stevenage Model Club. Pictures courtesy of Trevor Goodinson